



What Are the Health Effects Associated with Metals Found on PM?

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Introduction

- PM is a complex mixture of many different physical properties and chemical components. The relative potency of these components has not yet been clearly established.
- Ambient and emission source air pollution particles can include metals within the matrix of an insoluble component, within a soluble salt, and complexed at a surface.
- Metals which exist in more than one stable valence state can catalyze an electron transfer and therefore demonstrate some capacity to generate oxidants.
- Therefore, it is important for the EPA to better understand the contribution of metals to the adverse health effects observed in PM epidemiology studies.

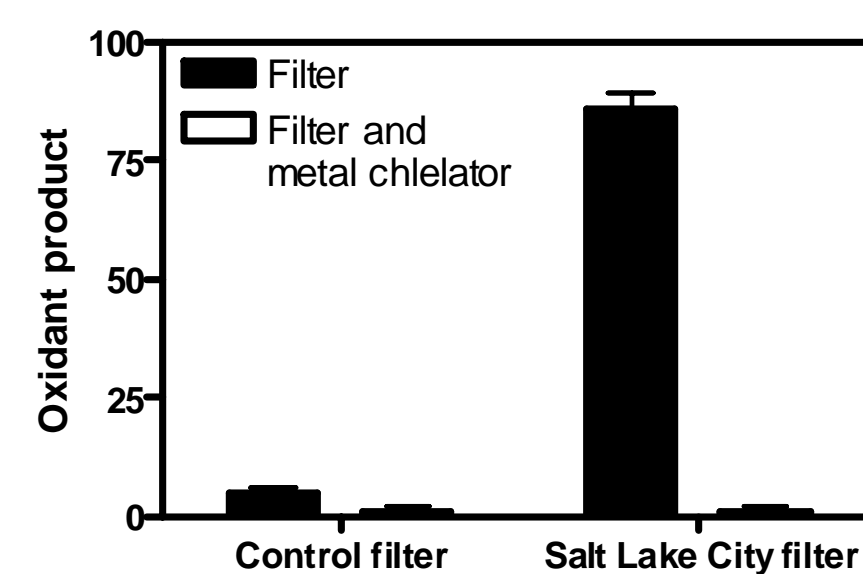
Do metals included in air pollution particles catalyze oxidants in vitro?

The capacity of air pollution particulates sequestered on filters from Salt Lake City to participate in electron transfer reactions was measured as oxidized products of deoxyribose and salicylate.

Correlations of metal concentrations on the filter with oxidant generation

	r value	p value
Ti	0.63	0.02
V	0.0.70	0.001
Cr	0.58	0.04
Mn	0.67	0.01
Fe	0.78	0.002
Co	0.72	0.006
Ni	0.35	0.24
Cu	0.43	0.14
Total	0.80	0.001

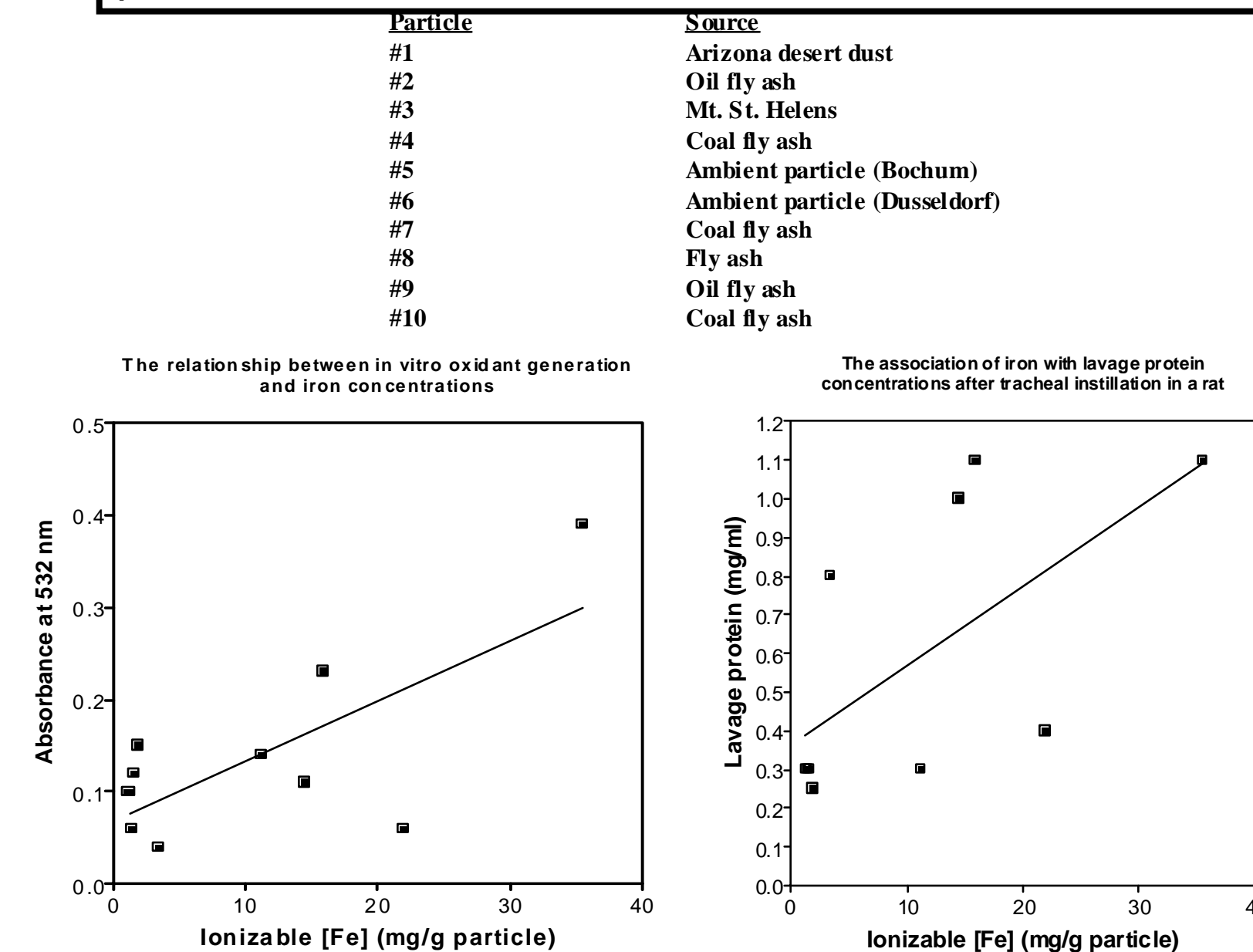
Oxidant generation by filter +/- a metal chelator



Conclusion: Metals on a filter correlate with in vitro oxidant generation

Do metals present in ambient PM cause lung injury?

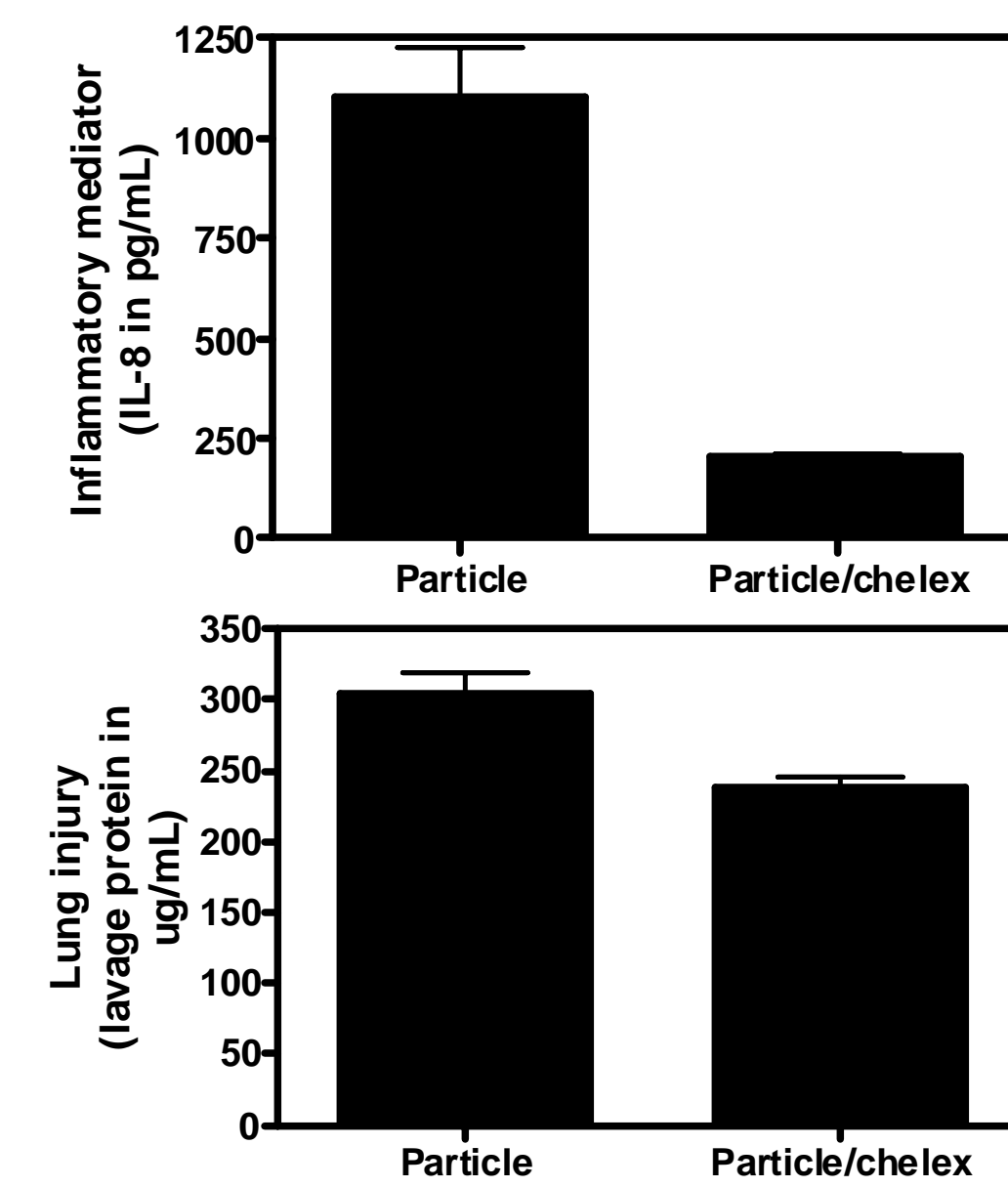
Metal concentrations in ten different air pollution particulates were measured. The capacity of the ten particles to participate in electron transfer reactions was then measured in vitro as oxidized products of deoxyribose (left panel). Sprague Dawley rats were then instilled with the ten particles and lung injury measured as lavage protein concentration.



Conclusion: There is an association between metal content of PM and the severity of lung inflammation induced by the particle.

Can PM-induced lung inflammation be decreased by metal chelators?

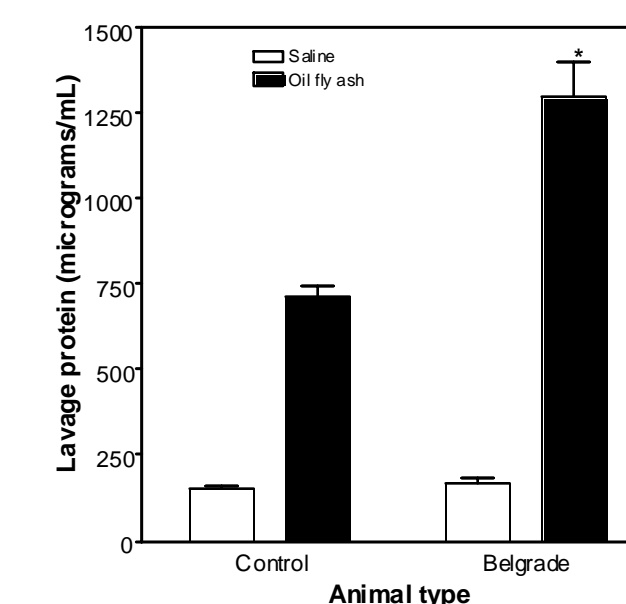
In vitro release of mediators by BEAS-2B and in vivo lung injury in rats was measured using an ambient air pollution particle with and without treatment by chelex, a metal chelate.



Conclusion: PM-induced lung inflammation can be blunted by the use of metal chelators.

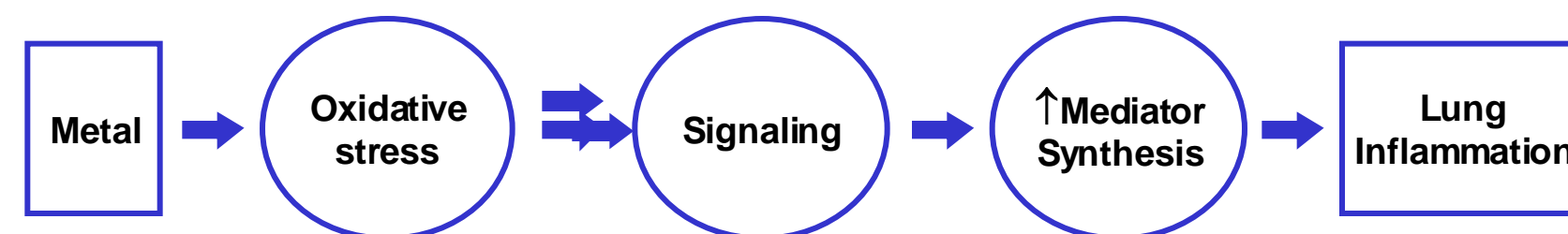
Can altered metal transport inside cells alter the biological effects of PM?

Controls and Belgrade rats (deficient in the metal transporter DMT1) were exposed to oil fly ash and lavaged 24 hours later.



Conclusion: inability to efficiently transport metals inside cells can exacerbate the effects of metal-containing PM.

Proposed Scheme of PM Metal Effects



Future Directions

- Is cardiopulmonary injury following PM exposure dependent on exogenous metals attached to PM or can PM exert its effects by mobilizing endogenous host metals?
- Identification of ways to blunt the effects of metal-induced injury using pharmacological tools.
- Better linkage of specific metals with individual sources.

Impact and Outcomes

ORD sponsored research has clearly shown that metals present in PM can cause cardiopulmonary injury via induction of oxidative stress. This provides important information to the EPA about an important PM component. Since metals are also linked to specific sources, these studies provide an opportunity to begin linking health effects caused by metals to specific sources of PM.

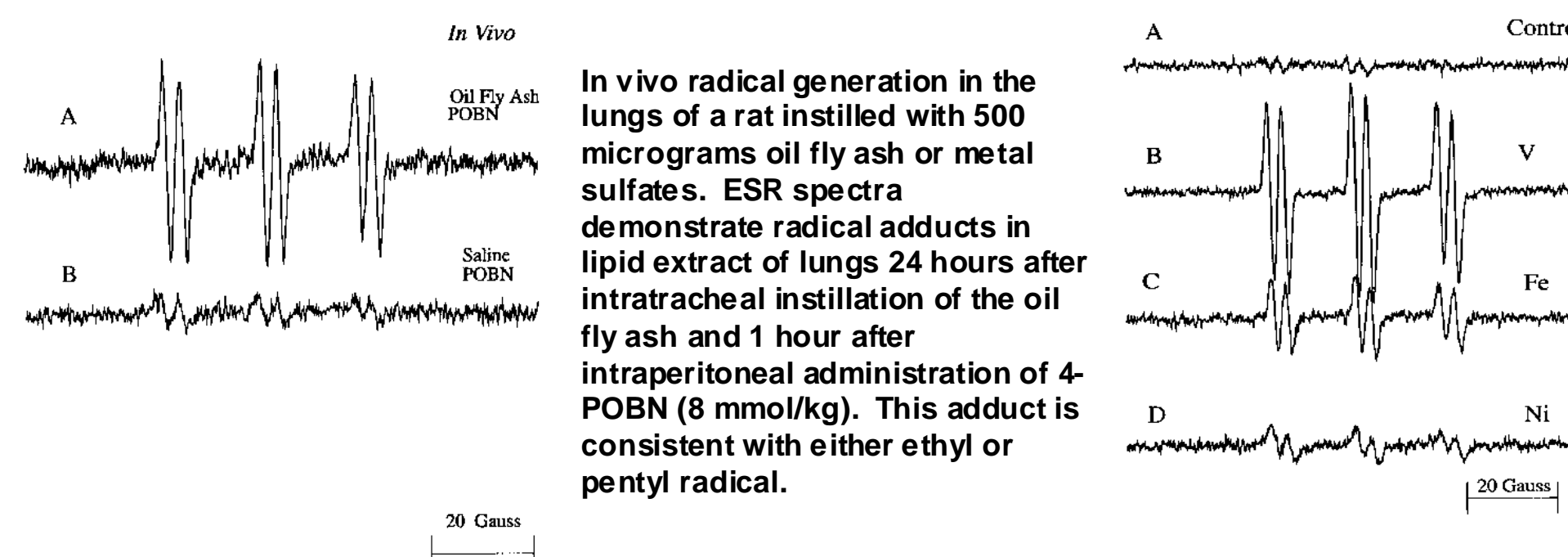
Are metals associated with air pollution particles?

Metal concentrations (micromolar) associated with particulate air pollutants on filters

	Ti	V	Cr	Mn	Fe	Co	Ni	Cu
Blank	0.0	1.6	2.4	0.5	13.6	0.0	4.7	0.5
Boston	7.0	7.0	0.5	7.7	122.4	0.0	4.3	18.9
Cottonwood Cyn	0.5	2.2	2.5	0.9	23.1	0.0	4.0	23.4
Dallas	0.0	7.7	2.7	1.7	49.4	0.3	3.8	26.6
Denver	4.1	22.6	12.4	7.2	78.1	0.4	5.5	19.2
Lake Forest Park	0.0	4.4	2.6	1.3	39.1	0.0	4.1	7.7
Newark	2.0	27.3	21.6	10.4	93.9	0.6	5.7	15.1
Ogden	0.8	3.7	2.6	1.7	30.2	0.0	4.0	6.2
Philadelphia	0.0	33.8	4.0	1.8	122.4	0.0	3.7	3.2
Pleasant Valley	1.0	3.9	3.2	1.1	40.1	0.0	4.0	4.2
Provo	13.1	147.2	38.2	100.3	1661.7	1.7	5.8	17.0
Salt Lake City	2.4	32.7	4.2	8.7	743.5	0.4	4.4	437.2
Trenton	0.0	74.3	5.3	11.2	111.1	0.4	3.9	1.0

Conclusion: Metals are included in particles sequestered on a filter

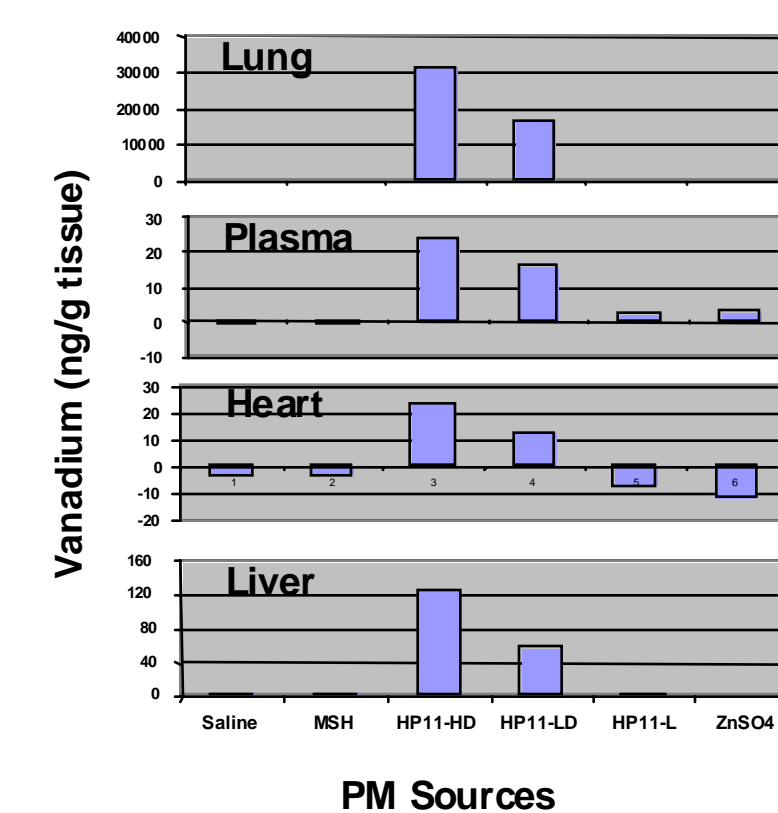
Do metals included in air pollution particles catalyze oxidants in vivo?



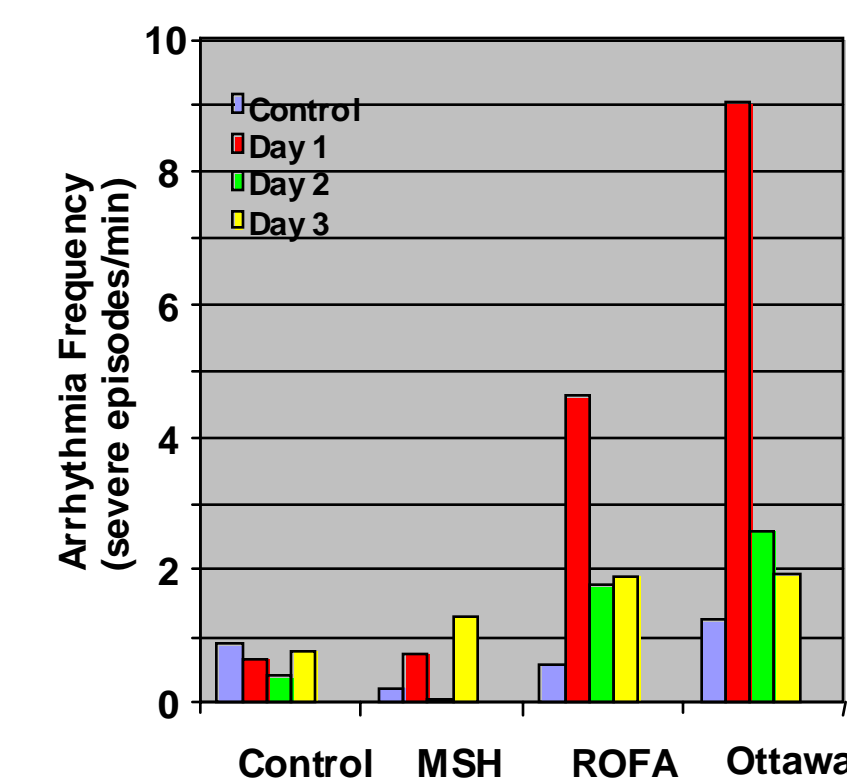
Conclusion: Metals on a filter correlate with in vivo oxidant generation in an animal

Do metals present in ambient PM cause cardiac injury?

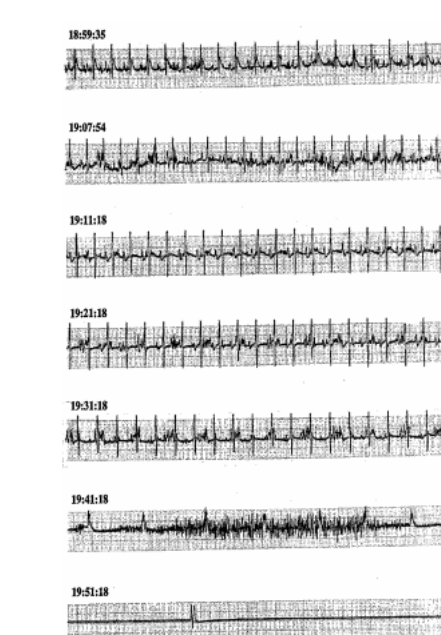
Rats were intra-tracheally instilled with PM from various sources once per week for 16 consecutive weeks. Tissues were isolated for metal analysis 2 days following the last instillation. The graph on the left shows V concentrations in different tissues



Conclusion: metals can leave the lung and contribute to cardiac injury following particle exposure.



Rats were treated with PM from various sources and arrhythmias measured for 3 days after exposure



Health and Exposure